

THE WEATHER AND CIRCULATION OF JUNE 1954¹

Illustrating the Birth and Growth of a Continental Anticyclone

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THE MONTH AS A WHOLE

For the third consecutive June [1, 2] heat and drought dominated the weather over the eastern two-thirds of the United States except for the northern tier of States, while abnormally cool, wet weather prevailed in the Far West (Charts I-B and III-B). On the other hand, the temperature and precipitation anomalies of this June were nearly opposite to those of the preceding month [3]. Table 1 illustrates this year-to-year persistence and month-to-month reversal for temperature. For example, 43 of the 76 stations which reported above (A) or much above (MA) normal temperatures in June 1952 also reported above or much above in June 1954. On the other hand, of the 21 stations which reported above or much above normal in May 1954 only 4 again reported above or much above in June 1954, but 13 reported below or much below. The precipitation patterns showed similar persistence and reversal, though not so neatly. Iowa was a notably exceptional area where the May-June reversal did not occur; instead, May rains were followed by June rains to produce record floods.

TABLE 1.—Number of United States stations¹ showing repetition or reversal of abnormal cold (B or MB) or warmth (A or MA) in June 1954 as compared with June 1952, June 1953, and May 1954 (approximate)

	Total	Same in June 1954	Opposite in June 1954
B or MB in June 1952	14	11	0
A or MA in June 1952	76	43	9
Total	90	54	9
B or MB in June 1953	21	17	1
A or MA in June 1953	65	41	2
Total	86	58	3
B or MB in May 1954	66	6	41
A or MA in May 1954	21	4	13
Total	87	10	54

¹ Based on 100 evenly distributed stations used by the Extended Forecast Section in verifying prognostic temperature patterns.

The 700-mb. circulation over North America (fig. 1) associated with this drought-flood combination contained certain elements of the heat-drought pattern observed in June 1952 and June 1953 as well as some characteristics

reminiscent of the Kansas flood situation of June 1951 [4]. The anomalous components of the flow, following the lines of equal height departure from normal, suggest an abnormal influx into the United States of air masses from the North Pacific Ocean, and less than normal influx of moist Gulf air into the Mississippi Valley. A moderately strong 700-mb. anticyclone existed in the Southeast, accompanied by positive height anomalies over the eastern half of the United States. A High center was also present at sea level (Chart XI) but with negative pressure anomalies in the area covered by the upper-level anticyclone, indicative of abnormal warmth in the layer between sea level and 700 mb.

These are familiar elements of summer drought circulation in the eastern half of the United States. T. R. Reed [5, 6] in the 1930's pointed out the importance of superimposed upper- and lower-level anticyclones in producing drought. A few years later a research group at Massachusetts Institute of Technology published an account [7] of the structure and dynamics of the continental summer anticyclone which could not be greatly improved upon today. Recent occurrences of this anticyclone, associated with the summer droughts of 1952 and 1953, have been related by Klein [1, 8] and Winston [2] to the abnormal strength of the jet stream along the Canadian border and to a well-developed Northeast Pacific High.

The planetary wave pattern within which the continental anticyclone of June 1954 was set, however, contained some unfamiliar combinations. The abnormally strong anticyclonic cell which extended over the Northeast Pacific at 700 mb. in June 1952 and June 1953 was replaced this June by an unusually strong westerly wind stream at middle latitudes (fig. 2), with heights below normal over the Aleutian Islands and Gulf of Alaska, and above normal farther south. Instead of the abnormally strong continental anticyclone over the United States being coupled, via a well-developed westerly jet along the Canadian border, to a deep cyclonic vortex in Canada, as in the previous two Junes, this June there was a strong positive height anomaly centered near Labrador and dominating eastern Canada. The common characteristic of these two different drought patterns is the existence of abnormally strong upper winds tangent in an anticyclonic sense to the

¹ See Charts I-XV following p. 172 for analyzed climatological data for the month.

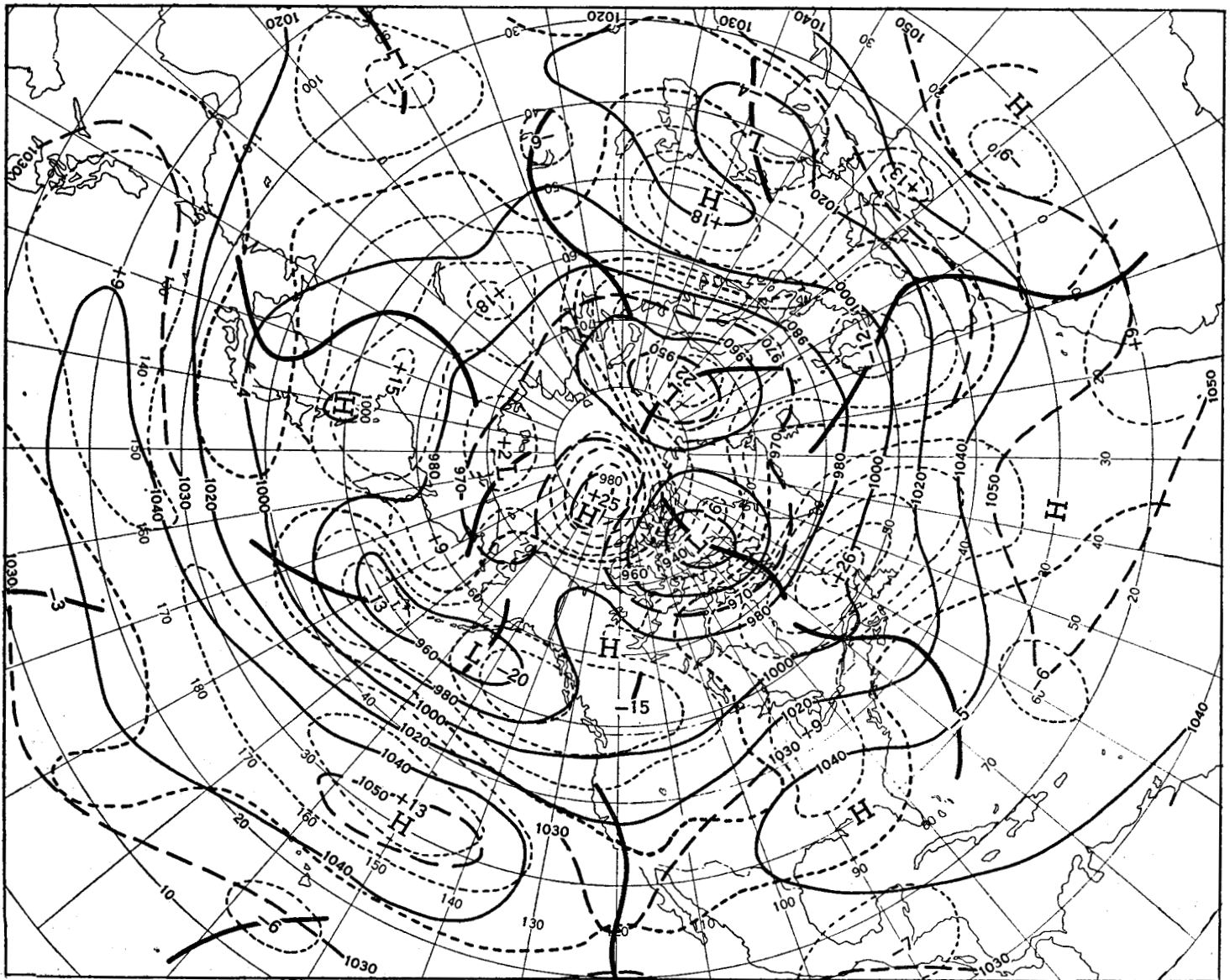


FIGURE 1.—Mean 700-mb. height contours (solid) and departure from normal (dashed) (both in tens of feet) for June 1-30, 1954. Abnormally strong Aleutian Low and East Pacific High poured cold Pacific air into the West while the circulation in the Atlantic and Europe was characterized by blocking, with anomalous cold troughs at low latitudes.

continental seat of the high-level anticyclone. In 1952 and 1953 there were strong westerlies on its north, while in 1954 there were strong southwesterlies on its northwest and northerlies on its east. It is of interest that the June droughts of 1933 and 1936 were accompanied by strongly anomalous southerly components along the west coast. This suggests that the banking mechanism postulated by Rossby [9], by means of which air is piled up to the right of strong, presumably supergradient winds, may be of primary importance in maintaining the continental anticyclone.

The principal features of this month's circulation which persisted from the preceding month were the abnormally fast Pacific westerlies (fig. 2) and the eastern Canadian "blocking High" (260-ft. positive height anomaly in fig. 1). The fast westerlies had shifted eastward, however, to pour cold Pacific air into the western United States, where the

weak May circulation had permitted abnormal continentality and therefore warmth. The negative anomaly center in the eastern United States associated with blocking in May had given way to a summer type continental anticyclone, bringing fair, warm weather to the Midwest. The eastern Canadian block, together with a deeper than normal trough off the east coast of the United States, produced recurrent "back-door" cold front passages along the Atlantic seaboard, similar to, but not as strong as, those of June 1953. Thus an eastward shift of the Pacific westerlies and the building up of a continental upper-level anticyclone were the main circulation changes associated with the May-June temperature reversal, carrying on the unusual sequence of month-to-month reversals which began last January [3].

Floods occurred on the Des Moines River in Iowa from June 17 to 24, and on the Rio Grande and its tributaries

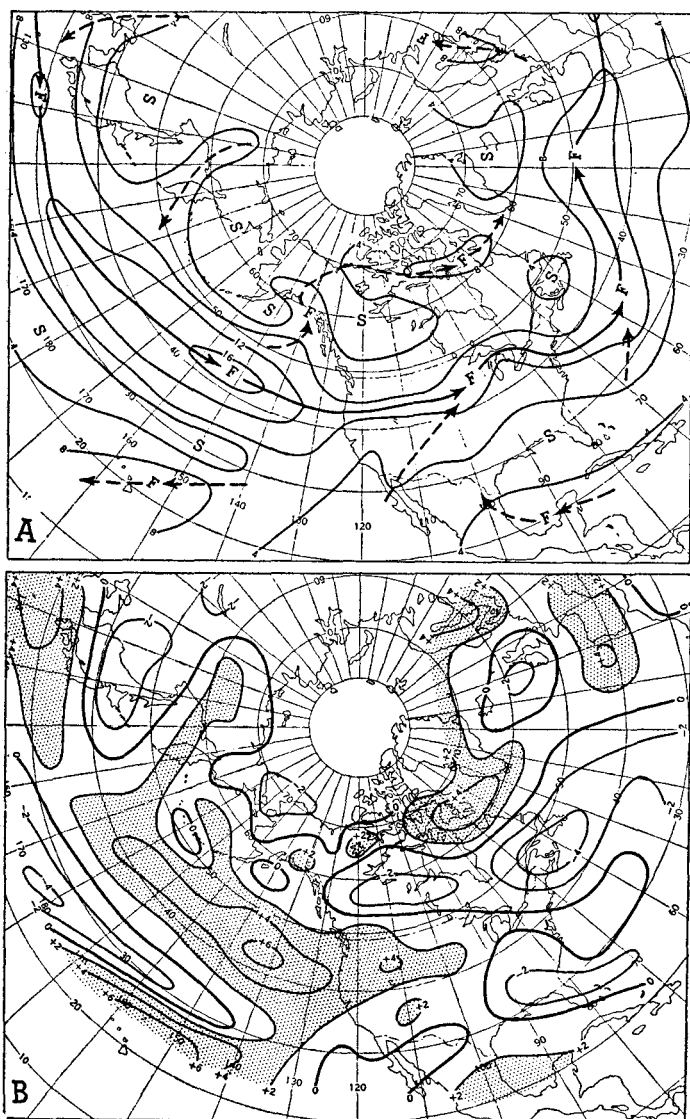


FIGURE 2.—(A) Mean 700-mb. isotachs and (B) departure from normal wind speed (both in meters per second) for June 1-30, 1954. Solid arrows indicate average position of the main 700-mb. jet stream, while dashed arrows indicate secondary axes of relative maximum wind speed. The middle-latitude westerly jet was abnormally strong in the East Pacific but weak in the Atlantic.

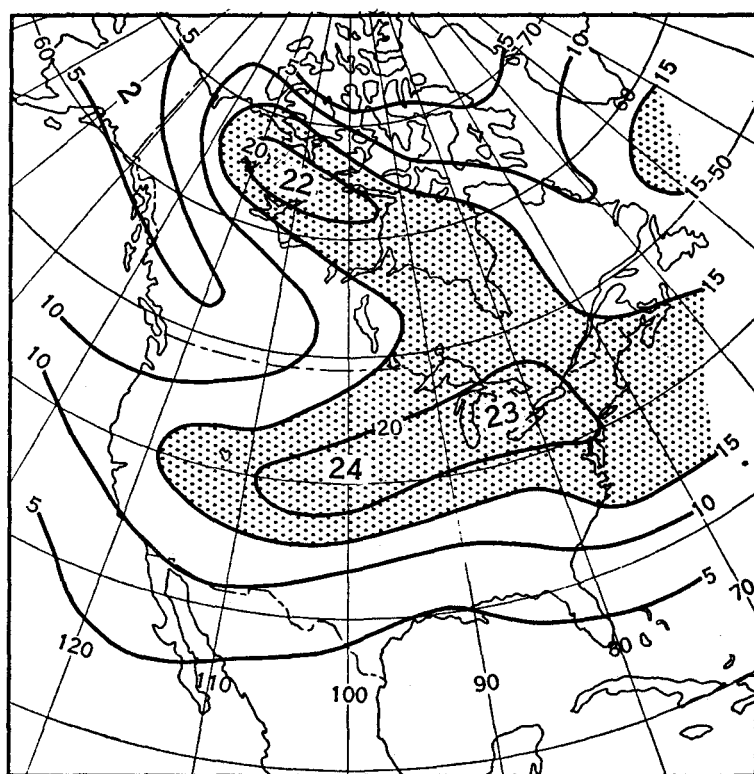


FIGURE 3.—Number of days in June 1954 with surface fronts of any type (within squares with sides approximately 500 miles). Frontal positions taken from *Daily Weather Map*, 1:30 p. m., EST. Heavy rains occurred in the North Central States where fronts were present as much as 80 percent of the time.

The Rio Grande floods can be associated with the onshore, cyclonic character of the anomalous component of the monthly mean flow across the west Gulf Coast at both 700 mb. (fig. 1) and sea level (Chart XI inset). These anomalies reflect the brief but strong cyclonic circulation accompanying the passage of Hurricane Alice, superimposed on a relatively normal pattern for the rest of the month. The drought in Oklahoma, Arkansas, and Missouri can be attributed to a persistent anticyclonic flow regime in this area rather than to lack of moisture, since this area was under the influence of both moist and dry air masses at different times.

Along the eastern seaboard, despite frequent frontal activity (fig. 3) record droughts occurred. Norfolk, Va., reported a total of 0.37 in. of precipitation for the month, well below the previous low of 1.05 in. recorded in 1921, and Savannah, Ga., reported a new record low of 0.84 in. compared with a previous low of 0.91 in. in 1891. Near-record low amounts were recorded over a wide arc from Washington, D. C., to Pensacola, Fla. This is not surprising when it is realized that little atmospheric moisture was available during most of the month, the flow having been predominantly from northerly directions with anticyclonic curvature.

Despite the accumulation of the extreme anomalies which have been mentioned so far, the weather of this month did not have a uniform character throughout. In fact, only in the Pacific Northwest were temperature departures of the same sign throughout the month.

in southern Texas from June 27 to 30. In between these areas record droughts occurred, with Fort Smith, Ark., for example, reporting only 0.38 in. of rain for the month, equal to the previous low June reading obtained in 1914. In a gross way these can be associated with certain features of the mean monthly circulation. Iowa is located in the region where the cold Pacific westerlies met the moist southwesterly current flowing around the western end of the continental anticyclone. There was also a zone of maximum frequency of surface fronts running from eastern Colorado across Iowa through the Great Lakes during the month (fig. 3). Chart III-B shows above normal precipitation along this zone from eastern South Dakota across the Lakes. Although somewhat off the axis of this zone of maximum frequency of fronts, Devils Lake, N. Dak., reported a record high June rainfall of 8.55 in. as compared with a previous high of 5.84 in. in 1914.

In the early part of the month a strong carry-over from the cold cP regime of May was evident, while in the last part some typical July characteristics became well developed. The warming, and with it the upper-level anticyclone and its associated moist and dry tongues, grew and spread westward during the month, from small beginnings in the Southeast. Chicago, Ill., which reported a high temperature of 65° F. and a low of 49° on the 4th, warmed to 97° on the 11th. Winnemucca, Nev., which experienced a severe June frost with lows of 23° on the 6th and 39° as late as the 17th, warmed to 107° on the 22d. The retrogression was not continuous; indeed, the transition from cool to warm in the Midwest and from north-central rains to southwestern rains was quite abrupt. The time sequence will now be discussed in more detail.

THE FIRST WEEK: MOSTLY COLD

Figure 4A shows the average temperature departure from normal over the United States for the period June 1-7, 1954. Figure 5A shows the precipitation amounts for the same week. Figure 6A shows the mean contours of the 700-mb. surface for the 5-day period June 2-6, 1954, which covers most of the same week. These can

be compared with Charts I-A and II and figure 1 to reveal the departure of this week from the character of the month as a whole. It is clear that the May regime of strong mid-Pacific westerly winds was still in force during this period. Encountering the persistent blocking pattern in Canada, the westerlies were depressed to relatively low latitudes in the United States; Pacific mP air, very cold relative to normal continental temperatures at this time of the year, overran the western part of the country behind a weak trough in the northern Rockies. Extensive frost and record-low minima caused considerable crop damage in the Great Basin. Farther east, this Pacific current was met by a stream of cold air coming southward from the Hudson Bay region to produce a strong trough in the eastern United States. Frontal lifting of the Pacific air produced considerable precipitation in the North Central States. Only in the extreme Southeast was any significant northward transport of warm, moist mT air occurring. A precursor of the continental anticyclonic cell had appeared over Mexico, from which warm, dry air was flowing into southern Arizona, New Mexico, and Texas.

Between the 5th and the 8th two impulses entered North America from opposite sides to end the cold regime

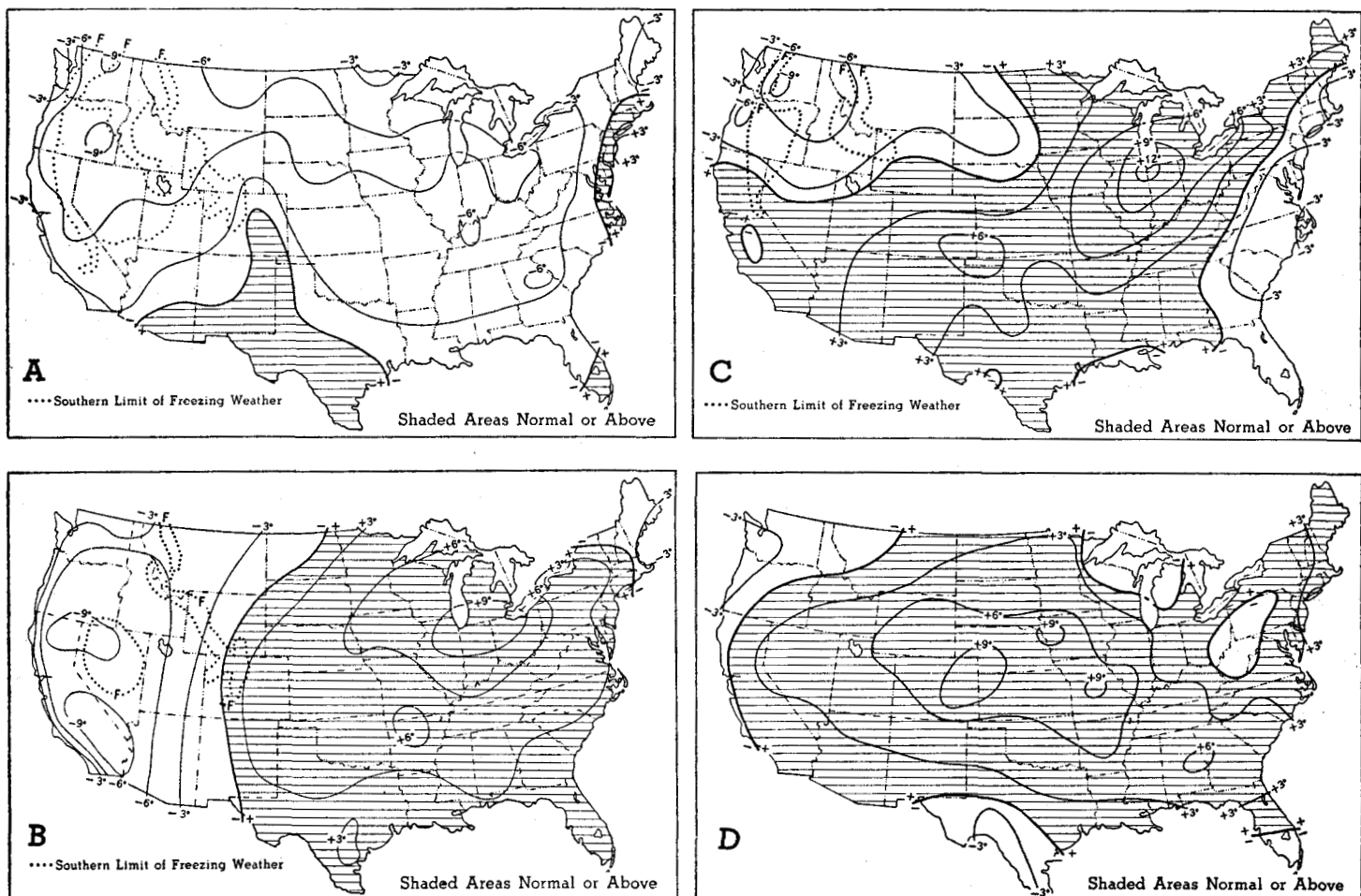


FIGURE 4.—Departure of average temperature (°F.) from normal for the weeks of (A) June 1-7, (B) June 8-14, (C) June 15-21, and (D) June 21-28, 1954. Heat replaced cold as the continental high-level anticyclone spread westward.

in the eastern and central United States. A deep Low entered Oregon aloft and moved slowly across the northern Rockies, accompanied by intense frontal cyclogenesis east of the Continental Divide (note deepening from 993 to 975 mb. from the 6th to 8th on Chart X) and by a shift of the upper-level ridge from the Southwest to the eastern United States. At the same time a retrograde upper-level High arched across Labrador from the southeast and merged with this ridge. This ridge became the seat of formation of the continental anticyclone; its persistence was reflected in the fact that a quasi-stationary polar front, oriented roughly NE-SW, was located on its western side, in the vicinity of Iowa, almost continuously from the 8th to the 21st.

THE MIDDLE PERIOD: WARMING IN THE MIDWEST AND FLOODS IN IOWA

The temperature and precipitation patterns for the weeks of June 8-14 and June 15-21, 1954 (figs. 4B and C, 5B and C) were relatively persistent and showed the same general characteristics as those for the month as a whole (Charts I-B and II). The upper-air circulation during this period, as represented by twice-weekly 5-day mean

700-mb. charts, also contained the essential features, with minor variations, of the monthly mean (fig. 1). Figure 6B, the 5-day mean chart for June 16-20, is typical of this period, and illustrates the changes from the earlier period. The Aleutian Low and the East Pacific High, well developed and with abnormally strong westerly winds between them, had progressed eastward toward North America, increasing the flow of cold air into the Pacific Northwest. At the same time a large anticyclonic cell had developed in the eastern United States, centered at first in the Carolinas. The middle-latitude trough and cold air which had been in the eastern United States passed off the east coast and became cut off. Part of this cold air and cyclonic vorticity appears to have entered the easterly current south of the continental anticyclone, contributing to early-season easterly wave activity and heavy rains in Florida and along parts of the Gulf Coast. Moist tropical air now began to be transported around the western end of the anticyclone into the Central Plains, for the most part in a field of general anticyclonic, subsiding circulation, finally to encounter the polar front and give copious rains in the region of confluence and lifting. Both the Pacific air from the west, curving cyclonically, and the Gulf air from the south, curving anticyclonically, joined

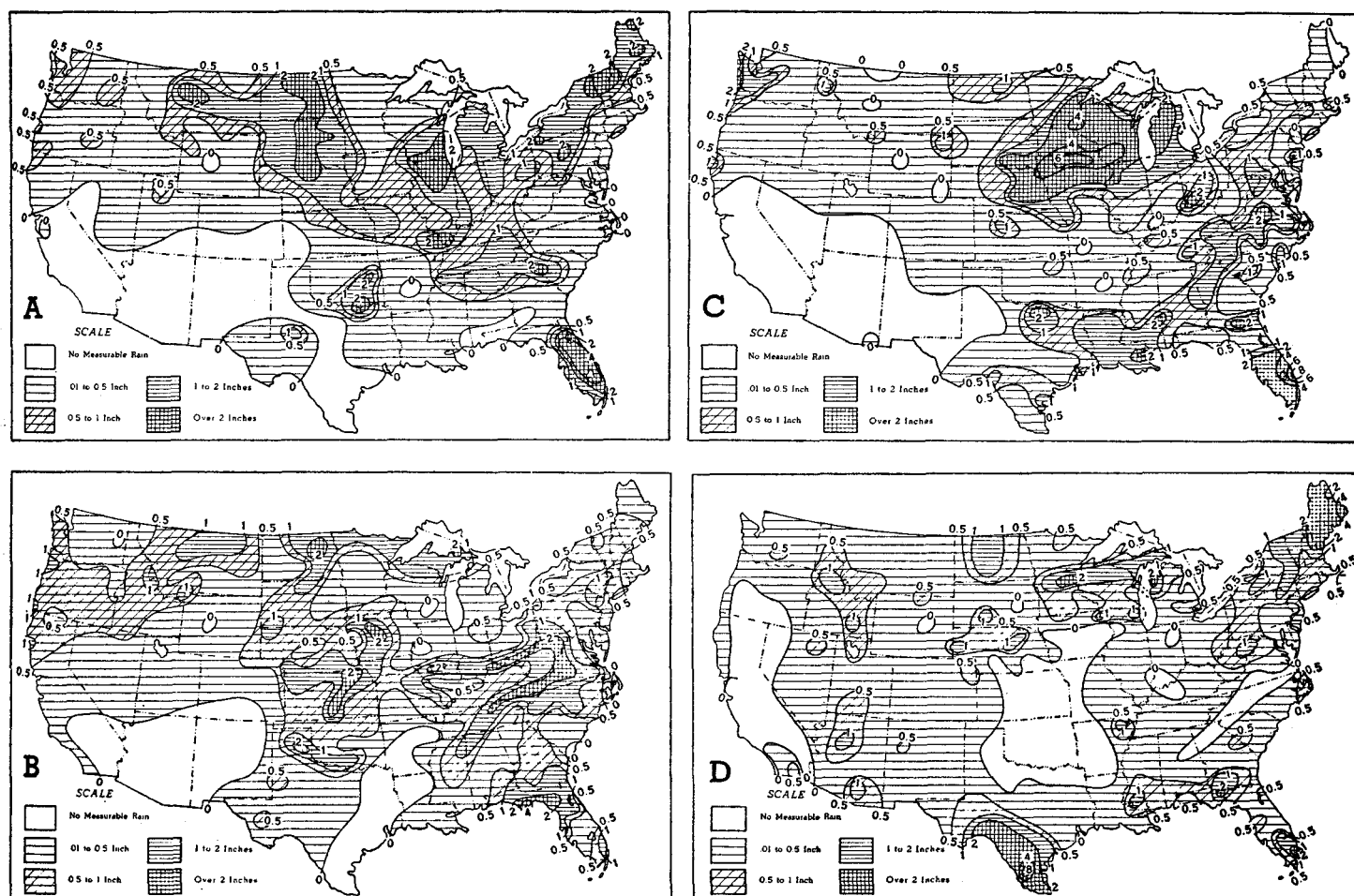


FIGURE 5.—Total precipitation (inches) for the weeks of (A) June 1-7, (B) June 8-14, (C) June 15-21, and (D) June 22-28, 1954. The rains shifted westward as the continental anticyclone expanded.

in a strong southwesterly current across central Canada. The sea level cyclone tracks shifted from southeast to northwest of Iowa during this period (Chart X) and the northwesterly cyclonic steering of sea level anticyclones crossing the Midwest gave way to southwesterly anticyclonic steering (Chart IX).

Thus the initiation of a continental anticyclone was favored by (1) increased west-southwesterly flow in the Pacific Northwest due essentially to momentum flux from upstream, (2) increased northerly flow along the east coast associated with the cut-off Low and westward propagation of blocking in the Atlantic, and (3) increased subtropical easterly circulation associated with easterly wave activity over the eastern Gulf of Mexico. This anticyclone, because of the seasonal heating differential between continent and ocean, then acquired dynamic characteristics (in particular, a very warm core) favoring persistence [7].

Toward the end of the third week of June, a large migratory upper-level anticyclonic cell, breaking off from the East Pacific High, entered the western United States, accompanied on its north by one of the strongest bursts of Pacific westerlies of the month. The sea level anticyclone tracks (Chart IX) show this as a retrogression of the East Pacific High from the 19th to the 21st and the formation of a new High center in Wyoming on the 21st. This shift of the jet stream to a relatively high latitude,

with marked anticyclonic vorticity on its right, ended the confluence and heavy rains in the North Central States. This transition will be discussed in the next section.

THE LAST PERIOD: RIO GRANDE FLOODS, "ARIZONA RAINS," AND WIDESPREAD HEAT

In order to show more clearly the rearrangement of moist and dry air currents which took place with the ending of the confluence in the North Central United States, charts of the mixing ratio on the 700-mb. surface for 0300 GMT, June 20, June 23, and June 26 are shown in figure 7. These can be related to the 5-day mean flow patterns for June 16-20, June 19-23, and June 23-27 (fig. 6B, C, and D). Although 700-mb. charts have been used in this analysis, the resulting patterns and their associated weather conform qualitatively to those described by means of isentropic analysis in the 1930's by Namias and Wexler [7, 10].

The migratory upper-level anticyclone which entered the West on June 21 passed eastward and merged with the continental anticyclone, resulting in retrogression of the 5-day mean High (fig. 6C) from the southern Appalachians to the central Mississippi Valley. The path of this travelling anticyclone is reflected in a strong east-west mean ridge across the western United States, with

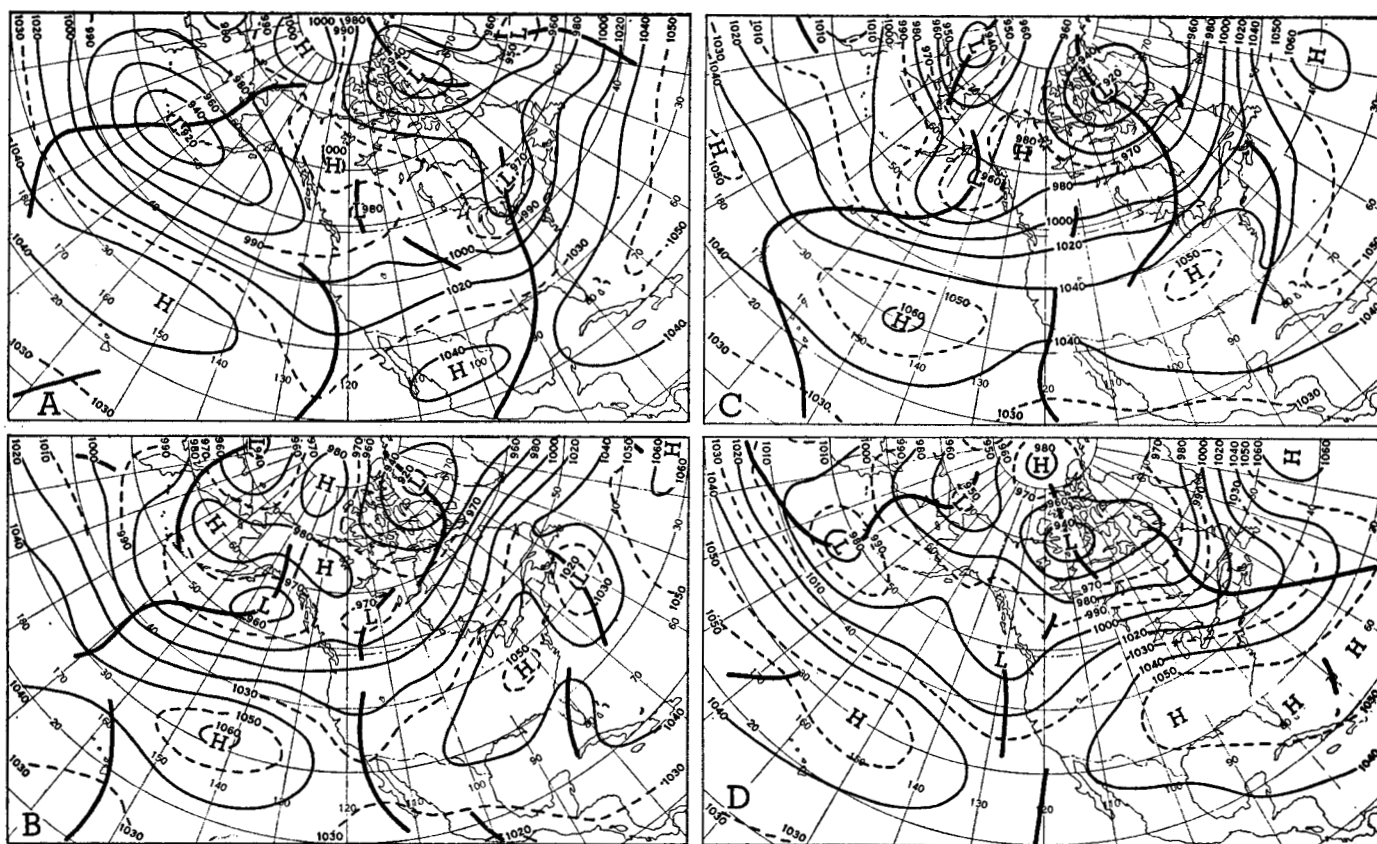


FIGURE 6.—Five-day mean 700-mb. contours (in tens of feet) for the period (A) June 2-6, (B) June 16-20, (C) June 19-23, and (D) June 23-27, 1954. A blocking surge crossed the Maritime Provinces from the east to merge with the incipient continental High in the eastern United States, while a maximum of westerly winds came across the Pacific and northern United States.

flat westerly flow on the north and flat easterly flow on the south.

Figure 7A shows the initial state of the 700-mb. moisture field preceding this intrusion of anticyclonic vorticity from the west. A moist tongue curved from eastern Mexico to the northern Great Lakes where it branched into two parts. A tongue of dry Pacific air curved cyclonically through Arizona and Colorado, while a second dry tongue covered the east coast and extended into the central Mississippi Valley. This instantaneous moisture distribution, observed at the end of the 5-day period represented by figure 6B, reflects closely the details of the mean streamlines, which had been relatively stationary during this period. To illustrate the previous histories of some of the air parcels, trajectories have been computed from the twice-daily 700-mb. charts. In constructing these trajectories it has been convenient to assume that each streamline pattern is stationary for 6 hours before and after map time and that the particles remain on the 700-mb. surface. On these assumptions, the heavy lines in figure 7 represent the travel, for the 5 days preceding the time of the mixing ratio chart, of the air parcels arriving at Sioux City, Iowa, Oklahoma City, Okla., Del Rio, Tex., and Washington, D. C. Positions of each parcel at 24-hour intervals are shown by heavy dots along the trajectories. While the particular air parcels do not, in general, remain at 700 mb., these trajectories can be presumed to represent, at least qualitatively, the antecedent travel of the main lower-tropospheric air streams arriving at these points. It can be seen that:

(1) The air at the 700-mb. level reaching northwestern Iowa, where torrential rains had fallen for the preceding three days and continued for one day following, was apparently of Pacific origin and had passed through the deep mean trough in the Southwest, curving cyclonically south of the Mexican border en route. Although not shown here, a trajectory arriving at the same time in central or southeastern Iowa was found to have come anticyclonically from the Gulf of Mexico. In other words, the histories of the two air streams arriving in Iowa on June 20 are fairly well represented by the 10,300-ft. and 10,400-ft. contours on the 5-day mean 700-mb. chart for June 16–20. The 6 gm/kg mixing ratio line roughly separates these two streams. Of course the actual values cannot be explained entirely by horizontal advection since Gulf moisture was undoubtedly being carried upward from lower levels.

(2) Both the dry air arriving at Oklahoma City and the moist air arriving at Del Rio at the 700-mb. level had come from over warm tropical waters. While the trajectories show no pronounced curvature, both were under the influence of a broad anticyclonic flow field during their 5-day travel. No significant rain was reported from either station on this date or for several days before or after.

(3) The dry cool air arriving at Washington, D. C., from

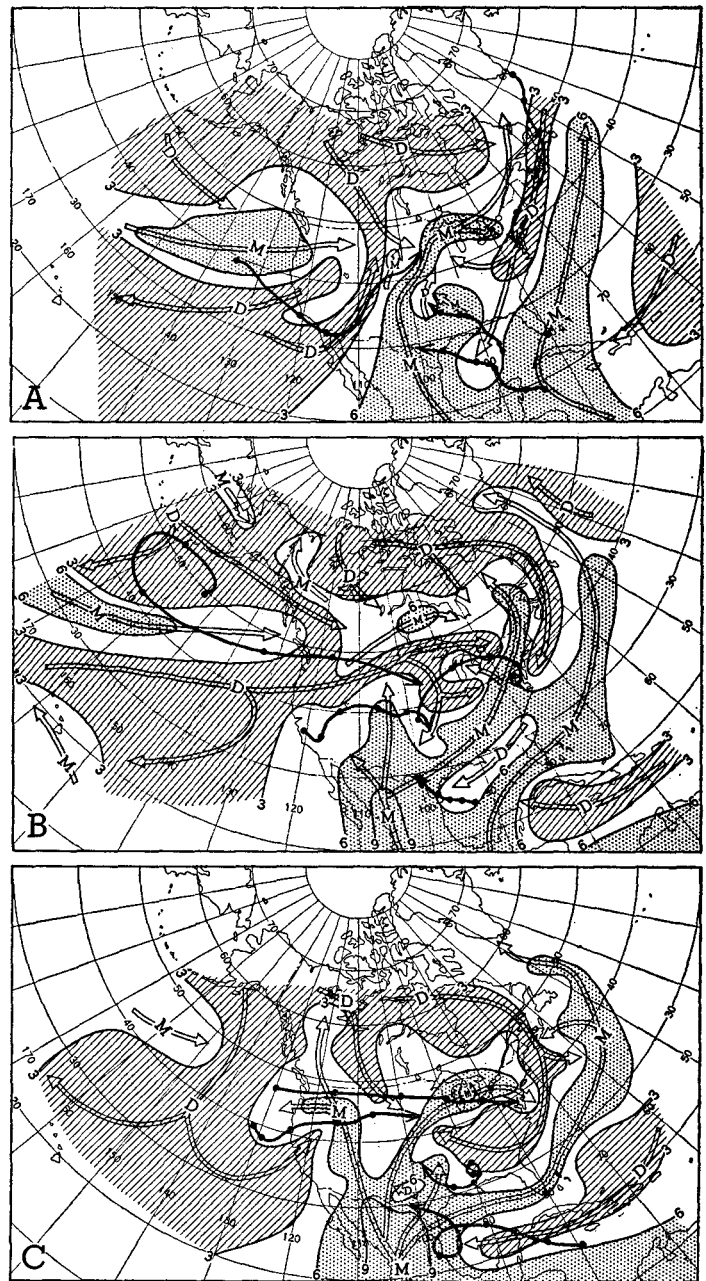


FIGURE 7.—700-mb. mixing ratio (gm/kg) at 0300 GMT for (A) June 20, (B) June 23, and (C) June 26, 1954. Areas of less than 3 gm/kg are hatched and areas of more than 6 gm/kg are stippled. Axes of relatively moist (M) and dry (D) are shown by double arrows. Trajectories for the five days preceding map time are shown as heavy arrows for air parcels arriving at Del Rio, Tex., Oklahoma City, Okla., Sioux City, Iowa, and Washington, D. C.; heavy dots mark 24-hour intervals along the trajectories. Moisture initially over the Great Plains was displaced by fast westerlies but a new supply appeared farther west when the anticyclone stagnated over the central Mississippi Valley.

the north on June 20 could apparently be traced back directly to the southern tip of Greenland 5 days earlier.

Thus qualitatively, toward the end of this period of relatively stable flow, the moisture axes (lines of relative maximum and minimum mixing ratio at map time), streamlines, and trajectories all told essentially the same story. Three days later (fig. 7B), however, some very striking changes had occurred, and the three sets of lines were no longer in accord. As we have seen, the sub-

tropical anticyclonic belt had bridged across the west coast in the 5-day mean (fig. 6C) and the center of the continental anticyclone had shifted westward cutting off the flow of Gulf air into the Midwest. The northern part of the moist tongue, initially located far west of the Mississippi River, had been displaced bodily to the east coast. It was replaced by a fast stream of dry Pacific air from high latitudes. South of the anticyclonic belt the moist air had been displaced westward. Large mixing ratios (over 9 gm/kg) had appeared at the 700-mb. level in western Mexico. Isolated showers began to break out in Texas, New Mexico, and Arizona, while the rains in Iowa had ceased. All four trajectories show some degree of anticyclonic curvature, although the mean streamlines are nearly straight.

By June 26 (fig. 7C) the transition to the new state was virtually complete. Pacific air had reached the Atlantic Ocean in middle latitudes and entered the quasi-stationary anticyclonic circulation over the eastern United States (fig. 6D) as a large dry tongue. The major point of entry of moist air into the United States had shifted farther west to Arizona, not an unusual position in late July or August, but abnormally far west for so early in the season. One tongue of moist air, curving somewhat cyclonically, extended northward from this source in the confluence zone east of the East Pacific mean trough. Associated with the moist tongue extensive shower activity occurred throughout the Plateau States on this and several following days. A second tongue branched to the northeast, curving anticyclonically without significant precipitation through the Central and Northern Great Plains, but producing rains in the Lakes States where frontal lifting was active.

Heavy rains began in the Rio Grande Valley on June 25 when Hurricane Alice entered the Gulf Coast south of Brownsville, Tex. (see Chart X). These rains progressed up the valley and, although lasting only about a day or two at any location, in contrast with the long regime of heavy rains leading to the Iowa floods, they produced the greatest floods of record on the Rio Grande. This was only a few days after the record flood crest had passed Des Moines, Iowa. Nevertheless, in the intermediate area of Kansas, Oklahoma, Missouri, and Arkansas no significant precipitation occurred during the entire last half of June. It is of interest that the mixing ratio at 700 mb. and lower levels was nearly the same at Del Rio and Oklahoma City on June 26. However, it is clear from the trajectories in figure 7C that the air arriving at Oklahoma City had travelled anticyclonically from near the center of the continental High, while that arriving at Del Rio had been caught in the cyclonic circulation around the tropical storm. This difference was, however, reflected in the moisture content at 500 mb., where the mixing ratio was 3.7 gm/kg at Del Rio and only about 1 gm/kg at Oklahoma City. This suggests that the vertical motion and moisture supply through a considerable layer above the 700-mb. surface, as affected by the field of

motion along the path, played a part in producing drought at one place and floods at the other. On June 28 the Texas rains were largely ended as the deep moist air over southern Texas was replaced by a tongue of dry air which can be seen progressing steadily westward in the three charts of figure 7.

During the fourth week of June daily maximum temperatures rose to over 100° F., first in Kansas and then in nearly all of the United States south of 40° N. New all-time high temperatures were recorded at Casper, Wyo., and Macon, Ga. Extreme heat is one of the essential characteristics of the quasi-stationary high-level continental anticyclone when well developed. As a result, the sea level Highs were weak in this area; the 5-day mean sea level charts showed high centers of about 1,017 mb. in the Southeast as contrasted with over 1,025 mb. in both of the oceanic subtropical Highs. Yet at 700 mb. the continental High was just about as strong as the oceanic subtropical Highs, while at 200 mb. the 5-day mean High of over 40,800 ft. over Kansas and Oklahoma for June 23–27 was the highest center in the Western Hemisphere. The large continental High with troughs over the oceans on both sides is a common summertime feature at 10–19 km. This was shown both by the high-level normal charts constructed by the Weather Bureau in 1944 [11] and through the study and typing of daily high-level charts by Wulf, Hodges, and Obloy [12].

SUMMARY

During the month the birth, growth, and retrogression of the continental anticyclone in a setting of high index over the Pacific and low index over the Atlantic was reflected in the temperature, moisture, and precipitation patterns as follows:

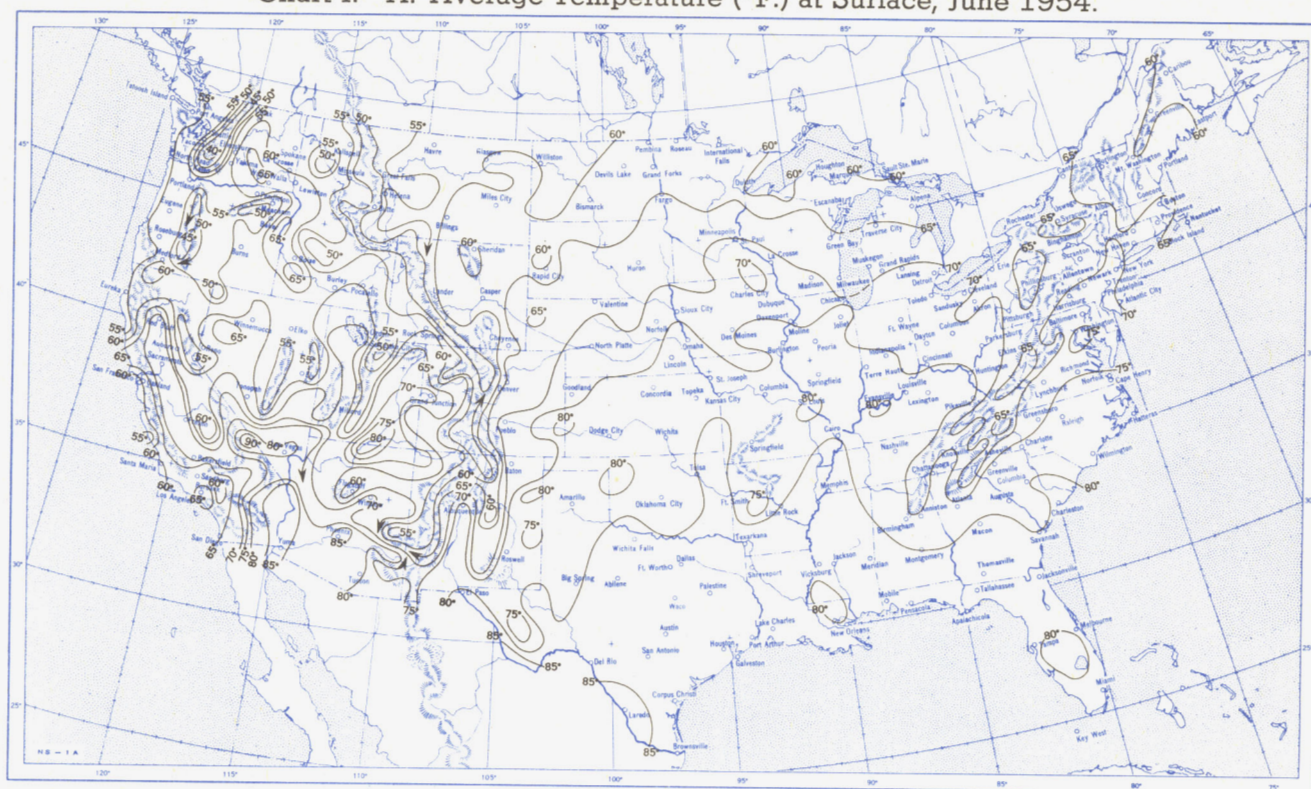
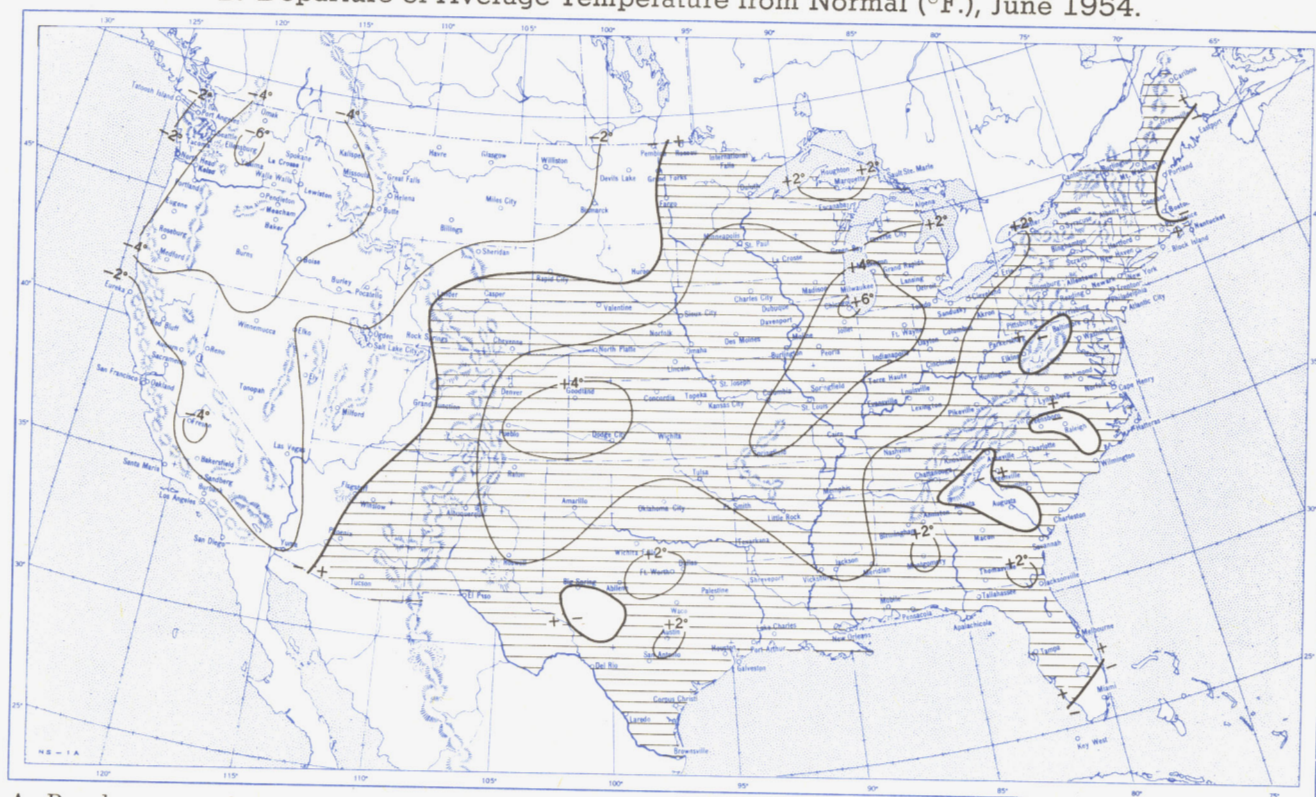
(1) *Temperature*.—Unseasonably cold weather, persisting from May and covering almost the entire country in the first week but with particularly severe frosts in the Great Basin, was replaced by unseasonable warmth, appearing first in the Mississippi-Ohio Valley and later spreading over most of the rest of the country to reach heat-wave proportions over large areas. Exceptions were the extreme Pacific Northwest which was dominated by cold Pacific air throughout the month, and the East which experienced repeated prolonged invasions of cool Atlantic air.

(2) *Moisture*.—The major tropical moist tongue entering the middle latitudes, at first virtually confined to the extreme southeastern States, came northward over the central part of the country during the middle of the month and shifted to the western Plateau States toward the end. Dry tongues from the Pacific, at first covering much of the country, retreated until they merely skirted the western and northern borders. Dry tongues entered the East at first directly from the North Atlantic and later from the Pacific, returning anticyclonically.

(3) *Precipitation*.—Frontal lifting was the predominant cause of precipitation in the first week with significant amounts occurring throughout most of the northeastern half of the country. Heavy rains also occurred in tropical air over Florida. During the middle of the month the most spectacular rains occurred in the North but drought began to develop in the central Mississippi Valley and parts of the Central Plains. The final third of the month brought showers to the Southwest and Western Plateau, with drought spreading over the Midwest.

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Chart I. A. Average Temperature ($^{\circ}\text{F.}$) at Surface, June 1954.B. Departure of Average Temperature from Normal ($^{\circ}\text{F.}$), June 1954.

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

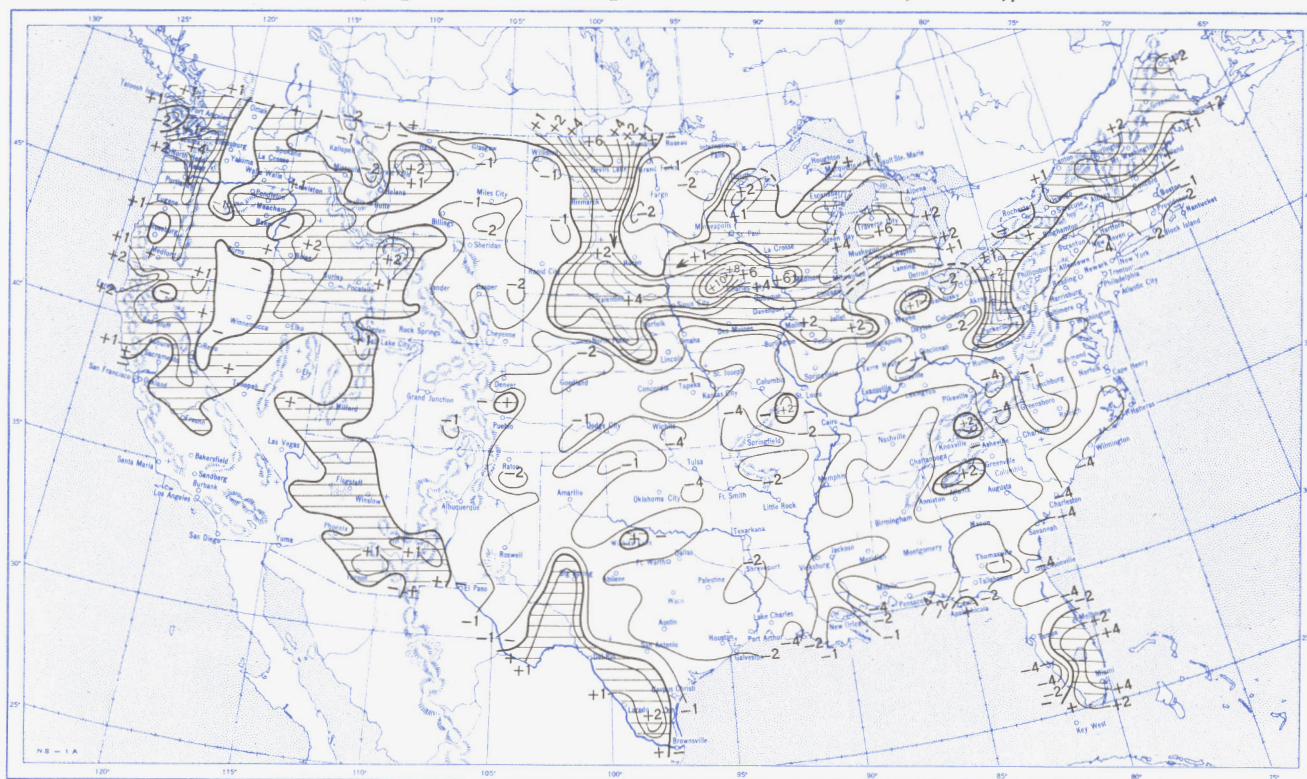
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), June 1954.

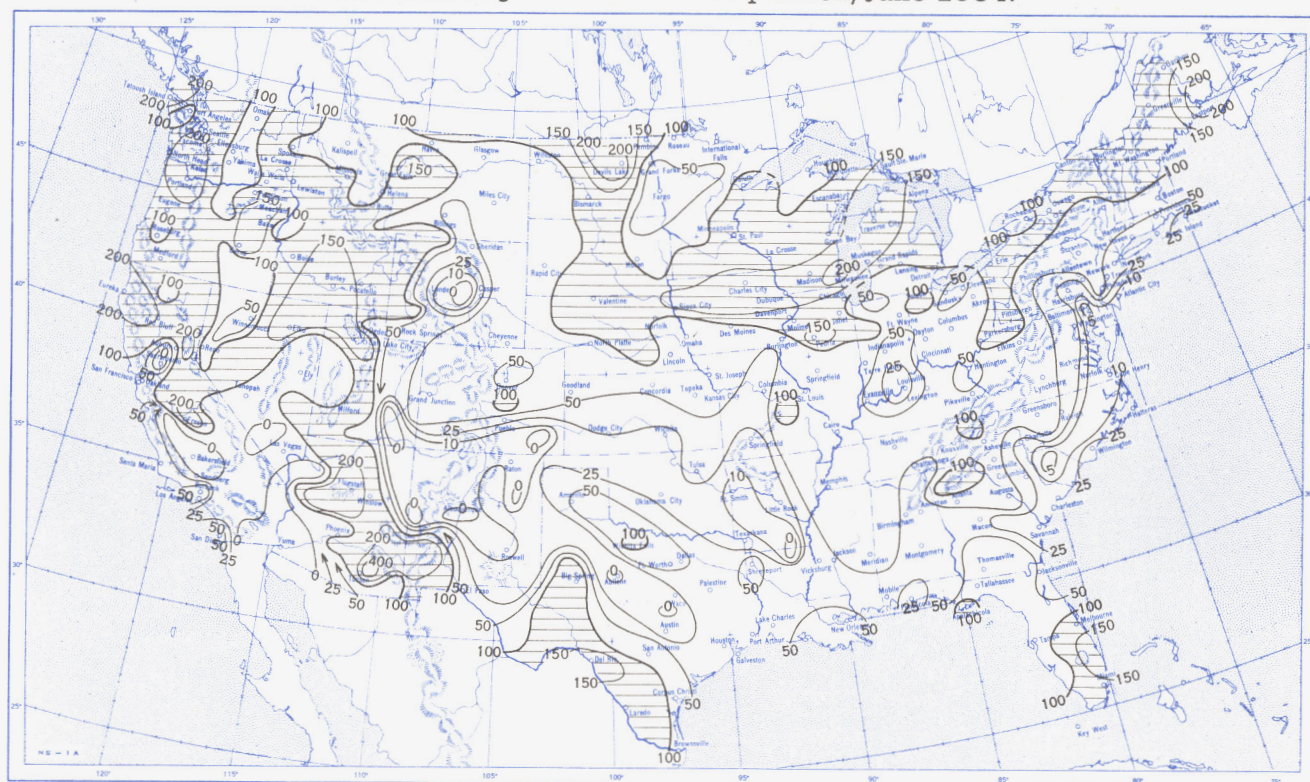


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), June 1954.

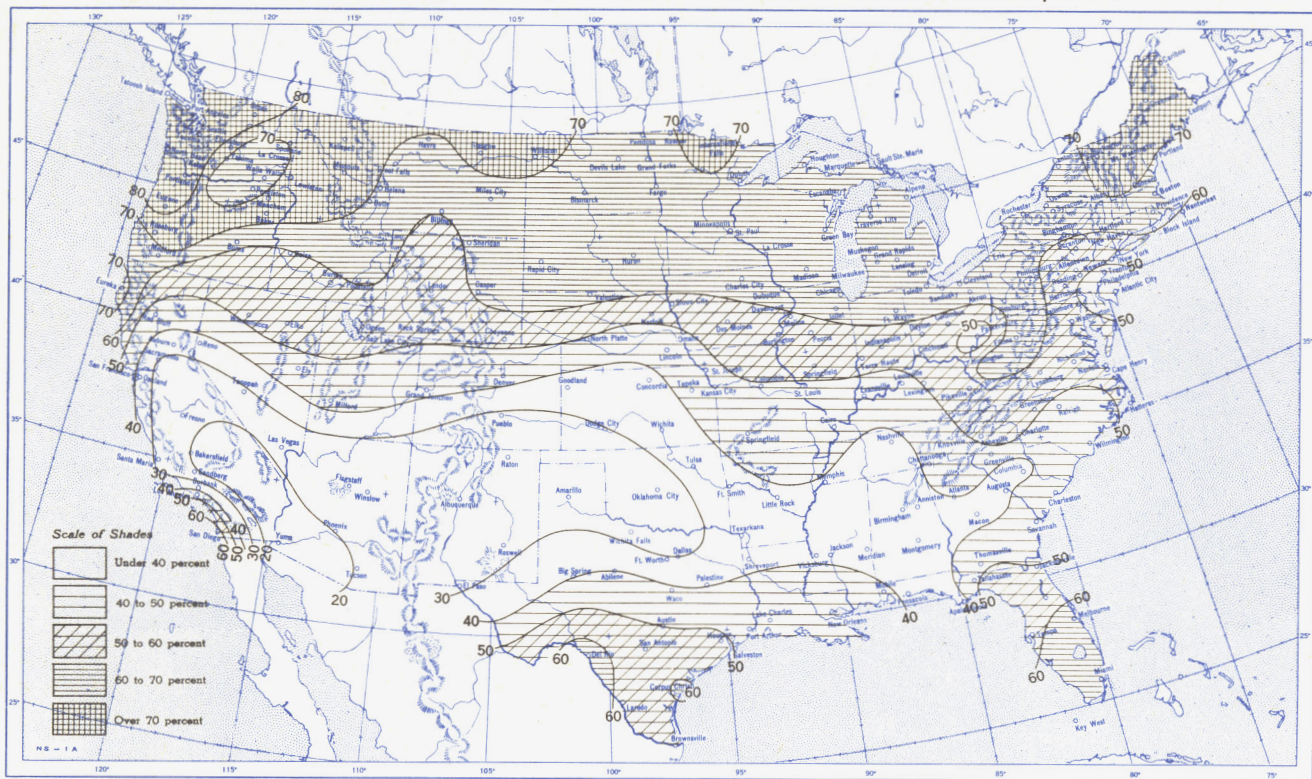


B. Percentage of Normal Precipitation, June 1954.

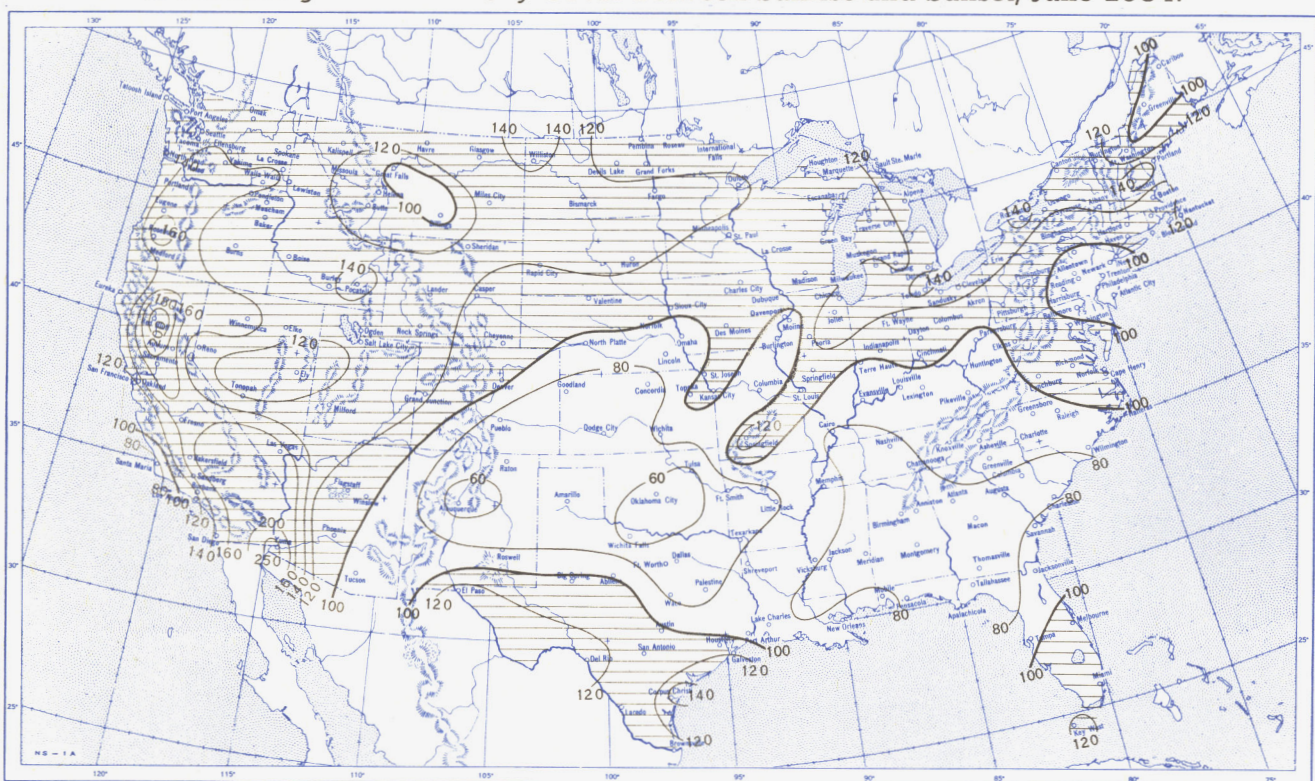


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, June 1954.

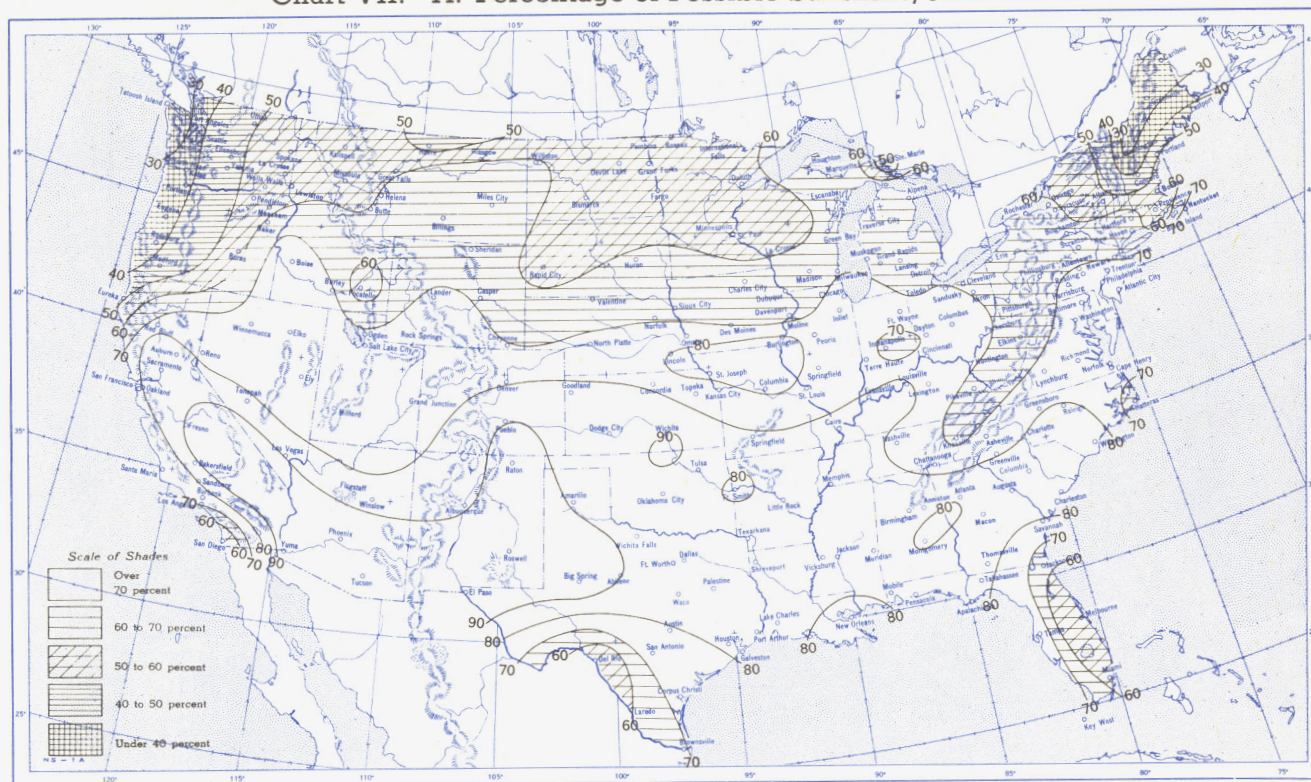


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, June 1954.

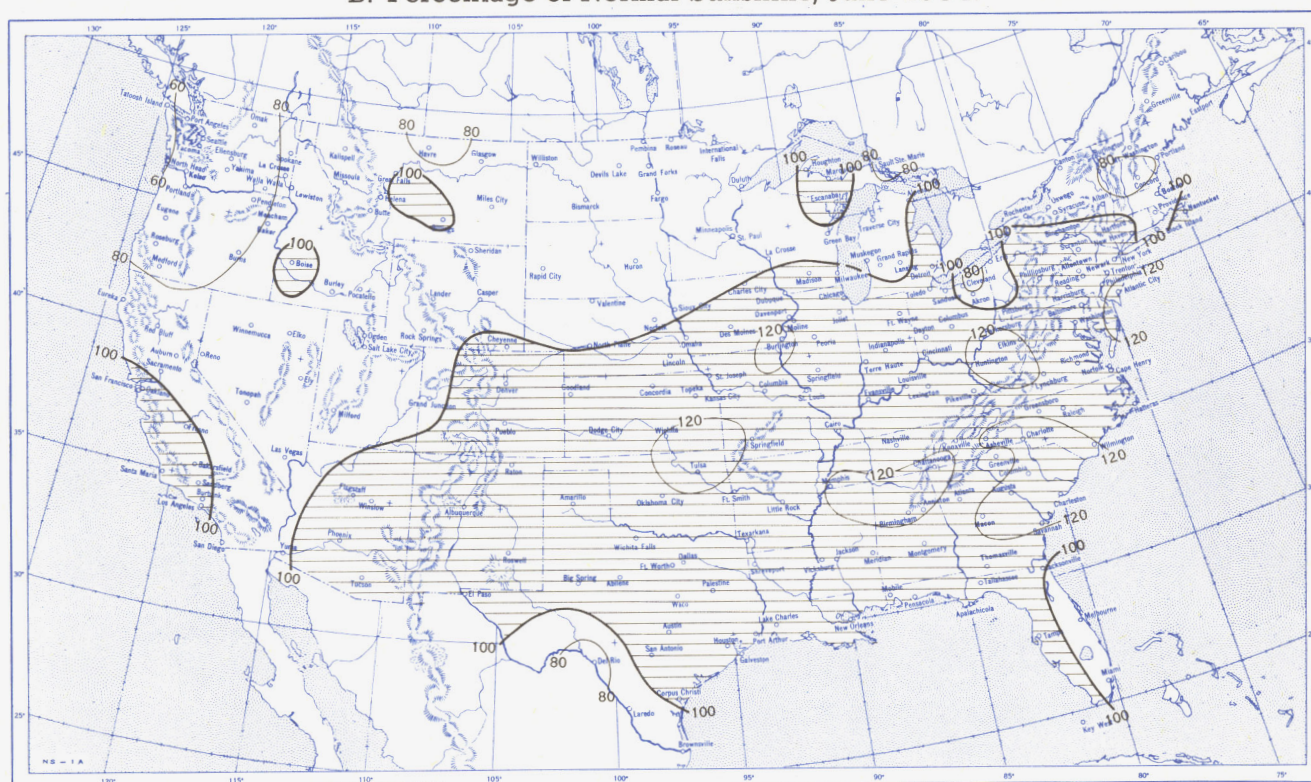


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, June 1954.



B. Percentage of Normal Sunshine, June 1954.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, June 1954. Inset: Percentage of Normal Average Daily Solar Radiation, June 1954.

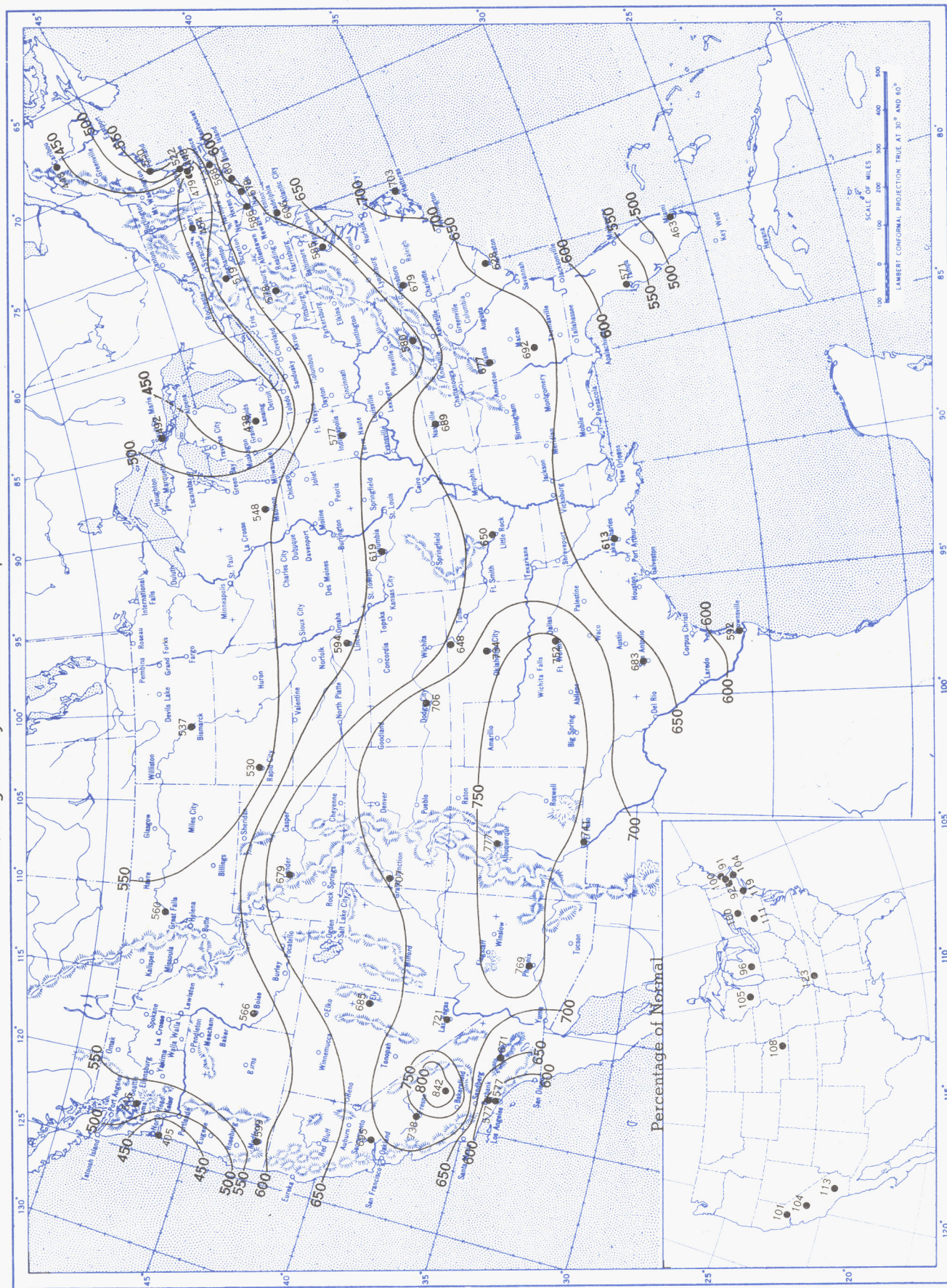
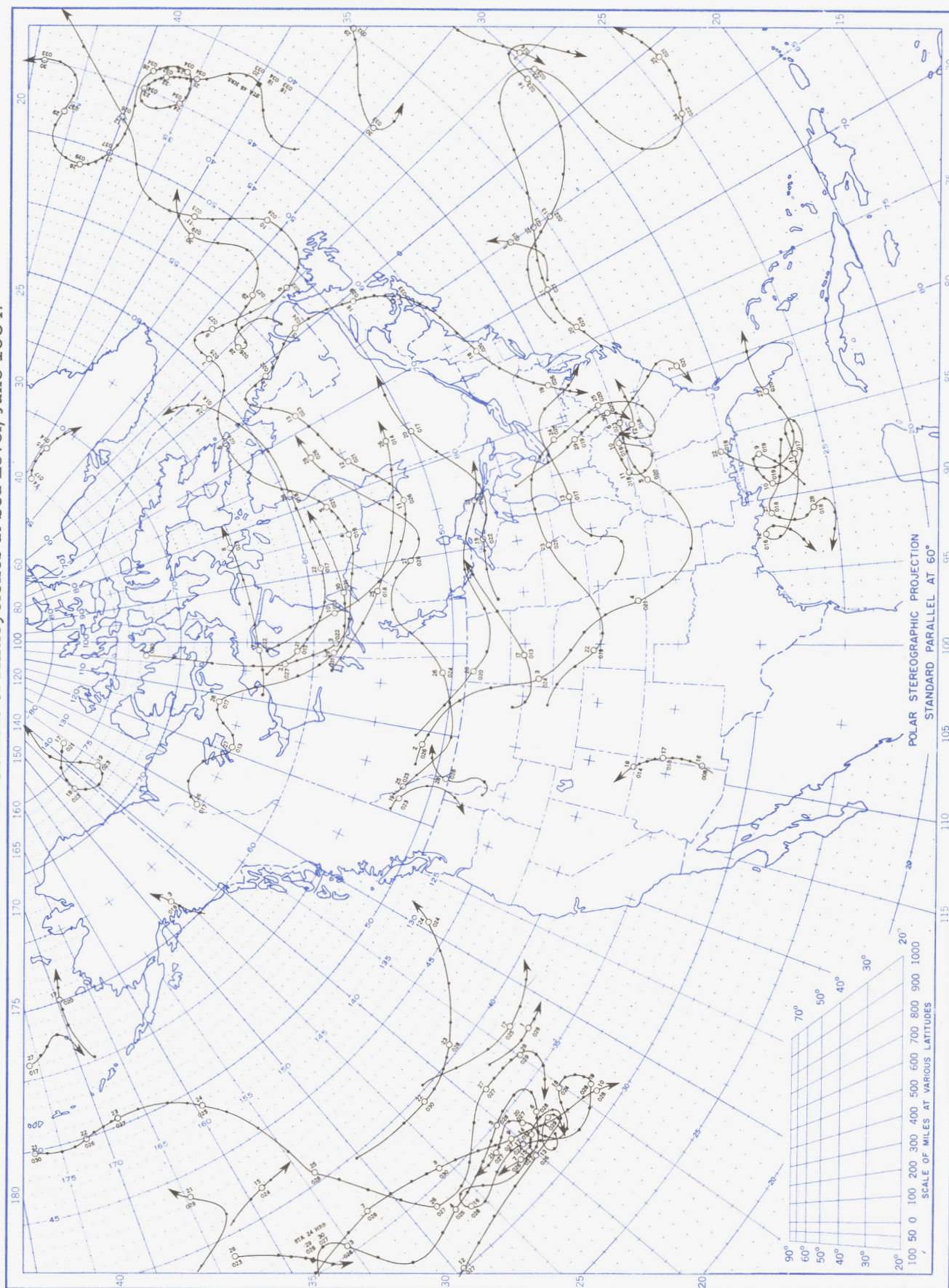


Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langley (1 langley = 1 gm. cal. cm.⁻²). Basic data for isotherms are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, June 1954.



Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar.
 Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, June 1954.

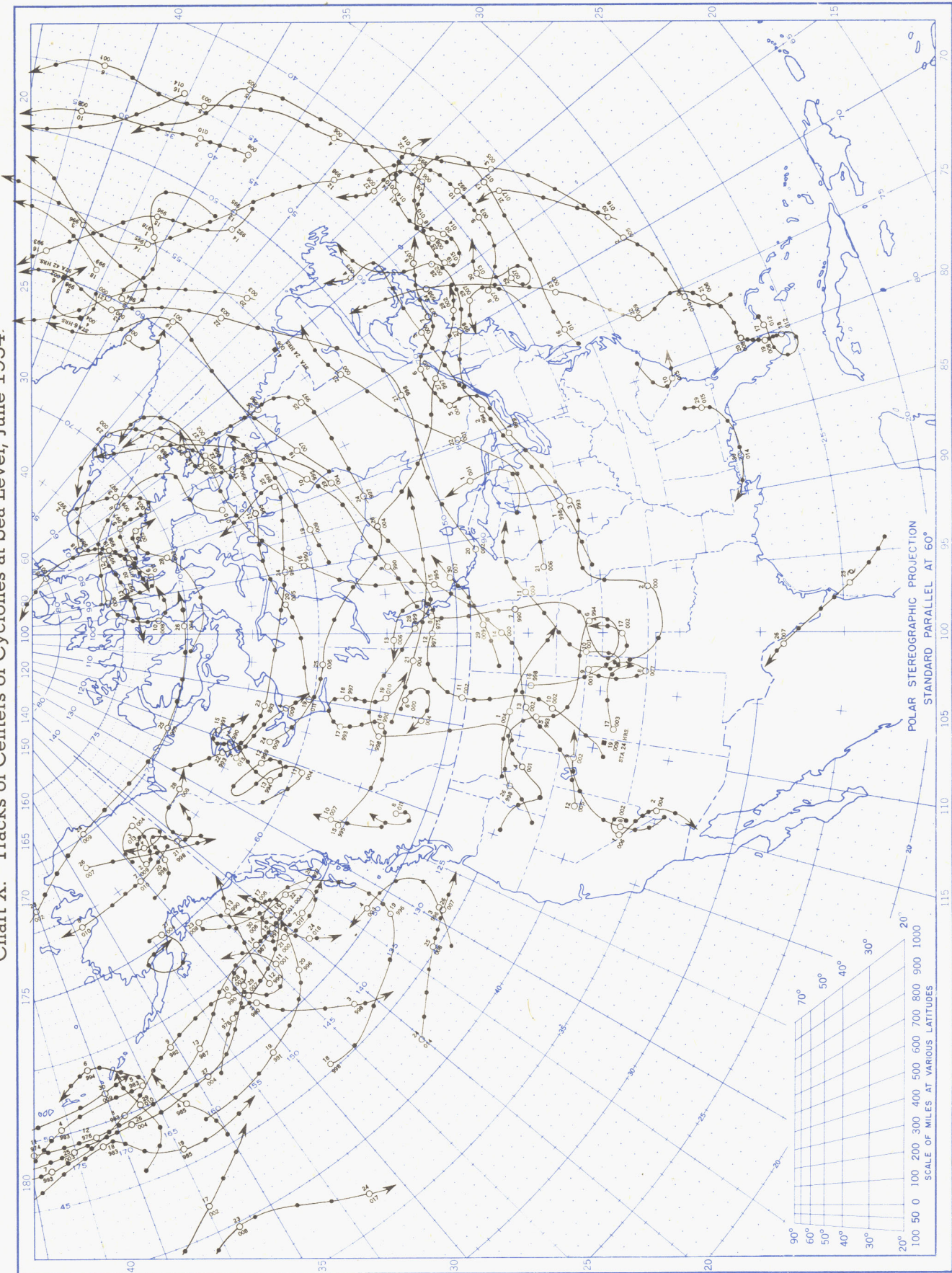
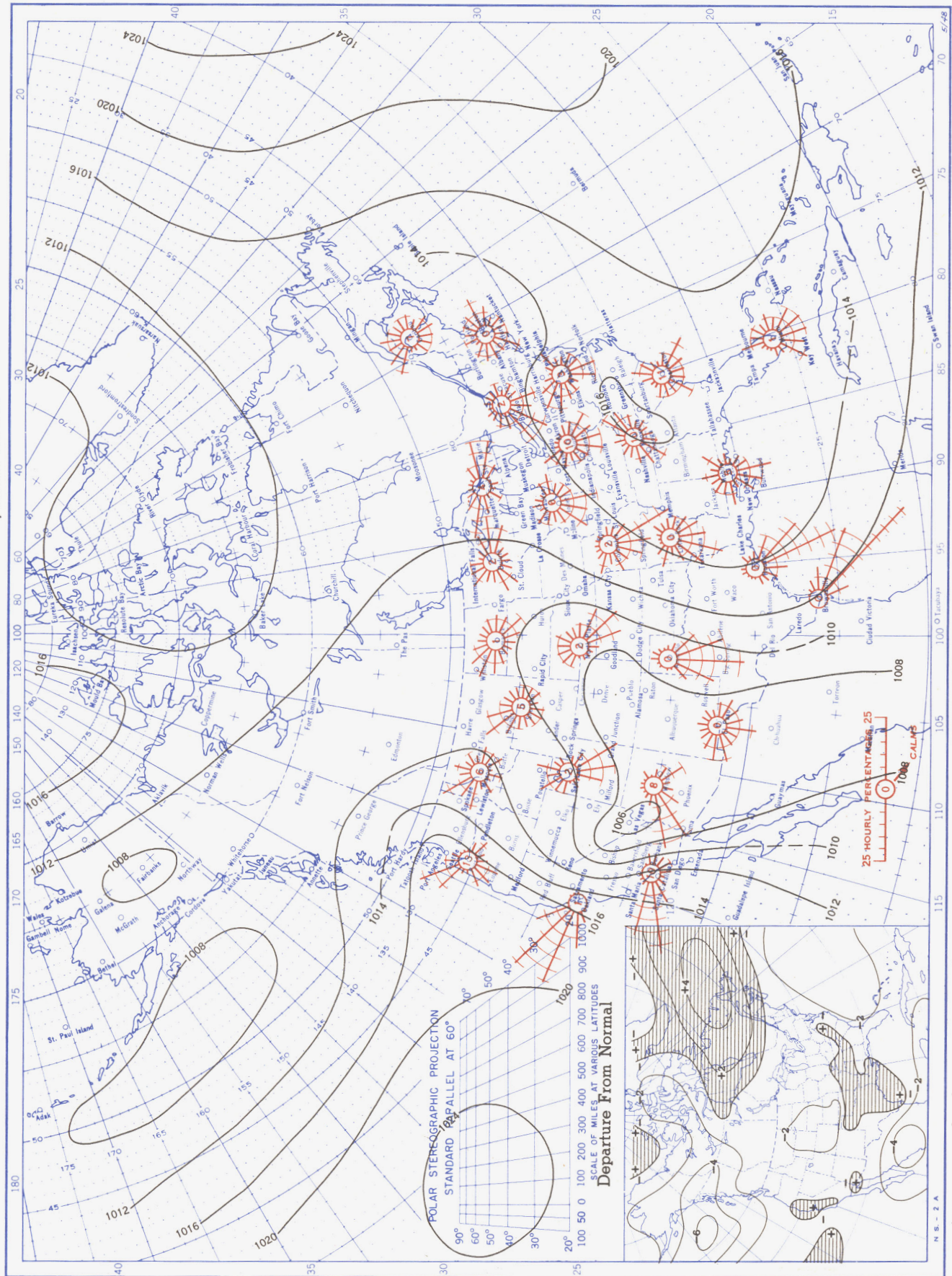
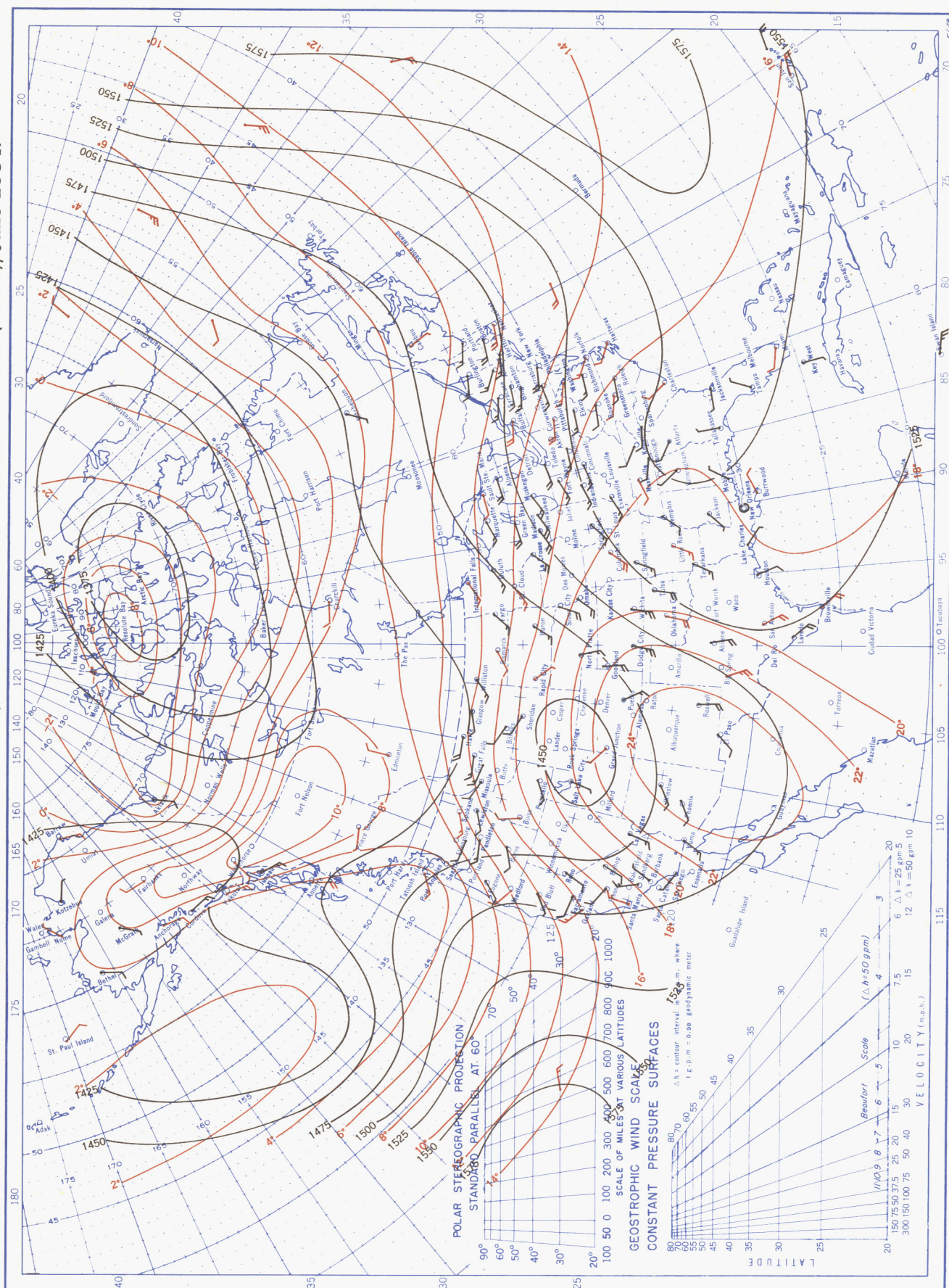


Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, June 1954. Inset: Departure of Average Pressure (mb.) from Normal, June 1954.



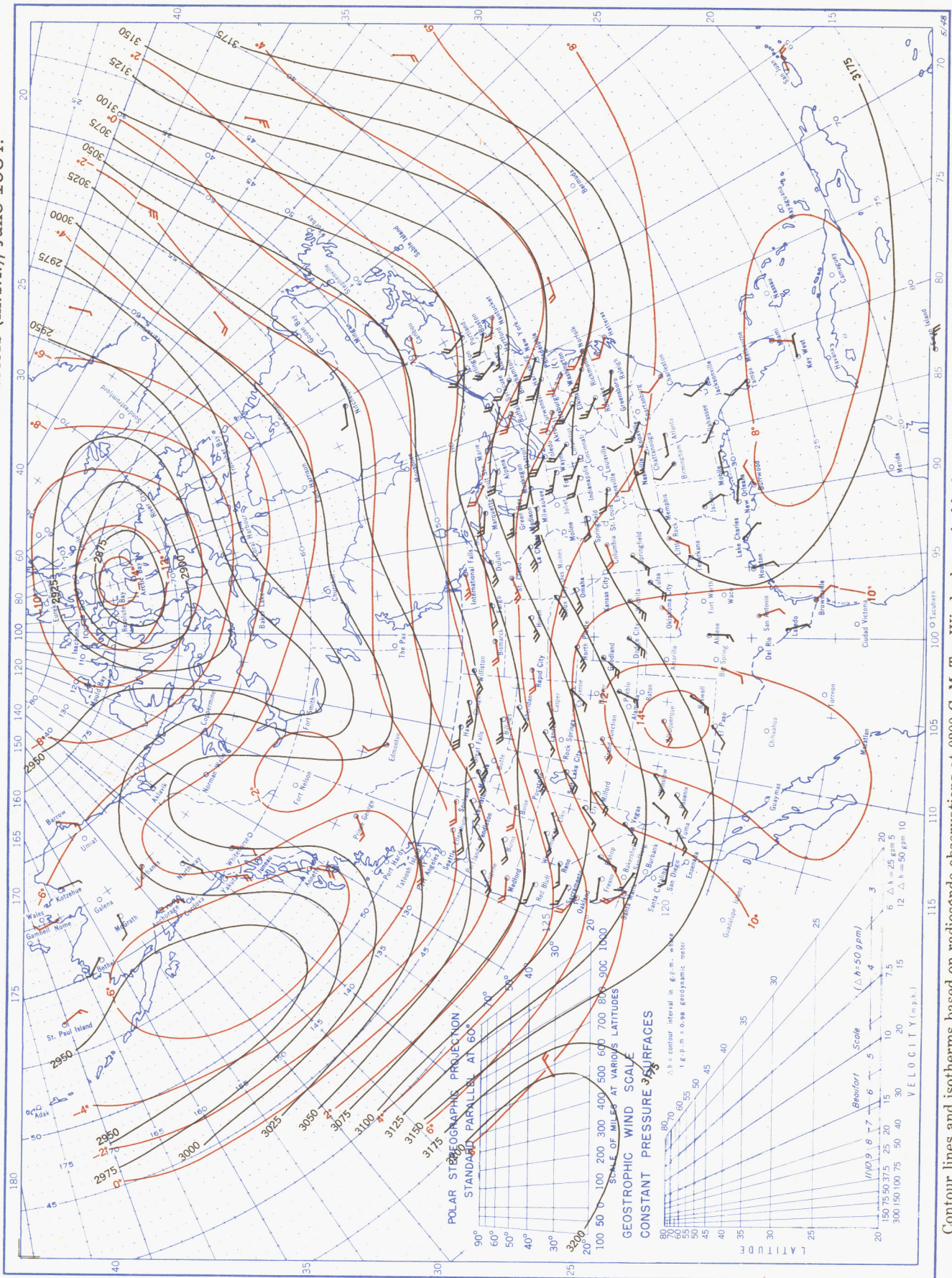
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° inter-sections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), June 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), June 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

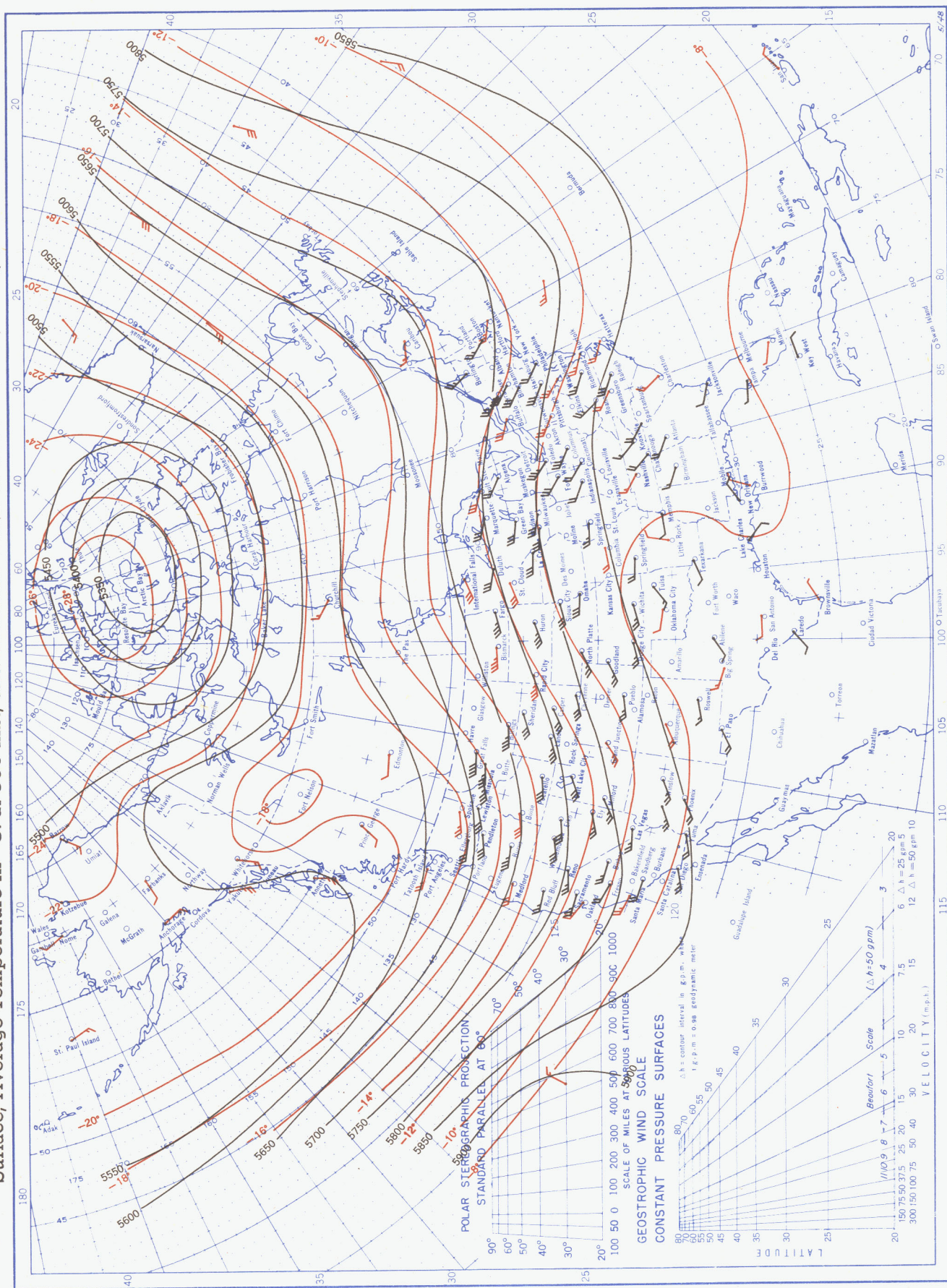
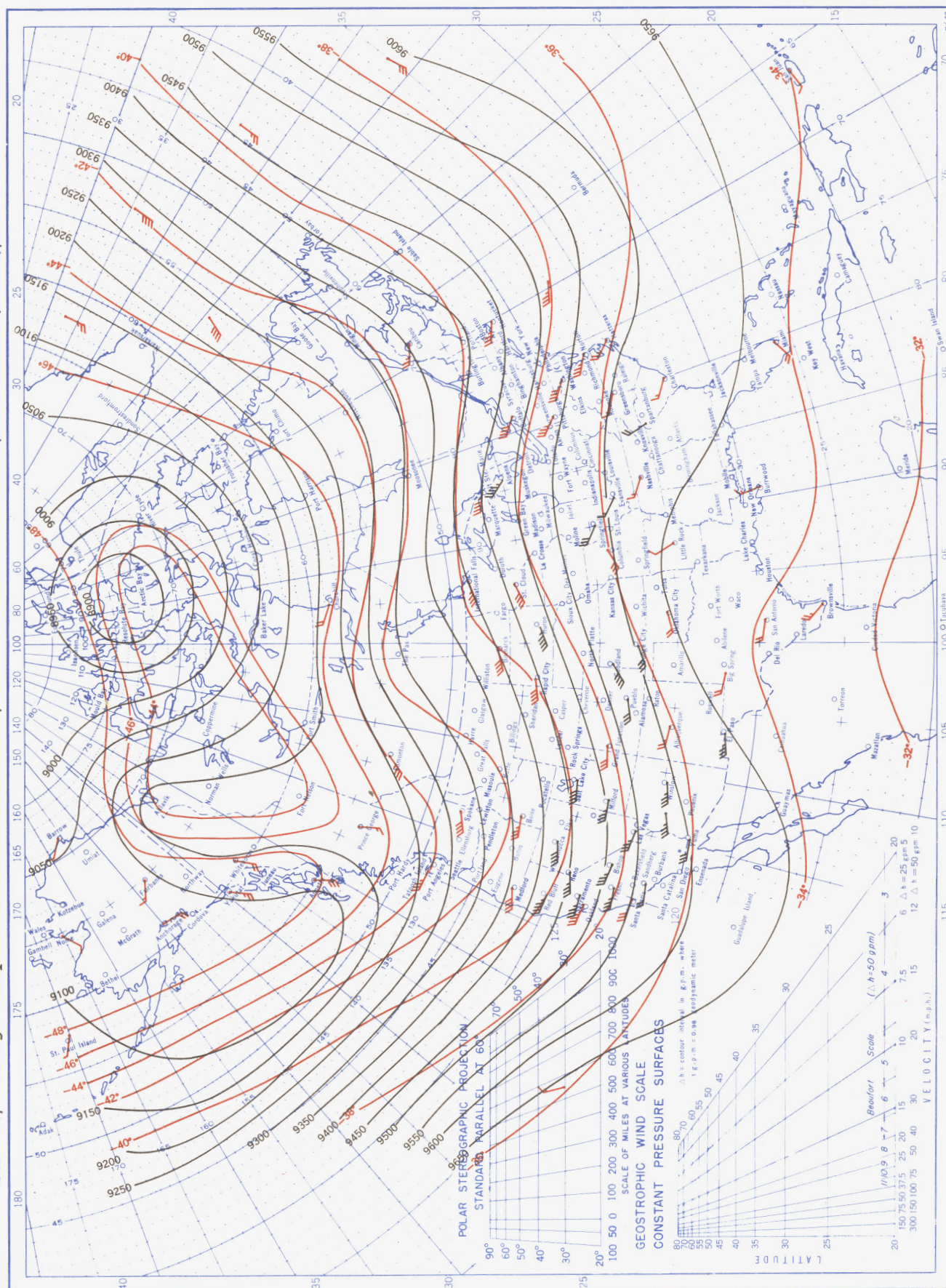


Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), June 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.